MST224 Guide

Introduction

Welcome to MST224 *Mathematical methods*. The aim of this 30-credit module is to provide a background in mathematical methods for students studying physical sciences, engineering, mathematics and economics. The module has been designed to provide the mathematical background required for level 3 modules offered by the Department of Physical Sciences, and level 3 modules in applied mathematics.

The assumed mathematical starting point is successful completion of MST124. However, we realise that some students will have studied MST121 instead, so we have designed Bridging Material to help fill the gap between MST121 and MST224. The scientific knowledge needed to study MST224 has been kept to a minimum, and there are no Science prerequisites. Occasionally, topics are best illustrated by a physical or mechanical example, and some of the teaching assumes a very basic knowledge of Newtonian mechanics.

The module is designed to teach the 'pencil and paper' techniques that are at the core of applying mathematics. Although the module does not teach the areas of physics and engineering where the ideas find applications, we believe that it is important to appreciate the context in which the ideas are applied. This is achieved by including background material that is highlighted as optional.

The mathematical techniques that are taught here form a basis for understanding the most sophisticated concepts in science. They distil insights that brilliant minds struggled to capture, so you should not expect it all to be easy. But after mastering these techniques, you will find that the same ideas and methods are used in many different areas of science and engineering. We hope that as you study science or engineering, you will become increasingly aware of the power of the ideas presented in this module.

Getting started and use of technology

The background knowledge that is assumed corresponds to successful completion of MST124, or equivalents.

This means that you are expected to be familiar with standard mathematical notation and elementary functions (such as sines, cosines, logarithms and exponentials). We also assume that you are familiar with algebra, calculus and complex numbers. The first unit is a summary of this background knowledge. We suggest that you read this unit quickly and decide which parts you might need to study more carefully.

You will need access to a computer in order to download assignments, and in order to do the interactive computer-marked assignments (iCMAs) that form part of the assessment. There will also be supplementary teaching materials (such as 'screencasts') made available online. These may vary between presentations. You will find details of these supplementary materials on the module website.

Although the module is teaching the 'pencil and paper' calculation techniques that a scientist or engineer needs to be able to apply, you do need access to a

scientific calculator, because some continuous assessment questions may ask for a numerical answer. The calculator will not be required in the exam, and you will not be allowed to take a calculator into the exam.

There is no programming or scientific software required for this module. There are numerous pieces of software that can assist with mathematical calculations, ranging from simple scientific calculator functions to sophisticated calculus. These are evolving rapidly, and some very useful software is already available free of charge. You are welcome to use these programs (outside the final exam) to check your work, or to give you hints. But you will receive full credit in your tutor-marked assignments only if you show sufficient working to demonstrate that you understand the methods.

You will have the option to submit the tutor-marked assignments (TMAs) electronically. The process for producing eTMAs on this module is different to what you may have been used to on other modules, so you will need to read the instructions on the module website carefully before submitting your work.

The module components

The module consists of a set of study texts, a handbook, a website and various assessment elements as described in the following pages.

Study texts

The module is based on printed text, supplied as four books, including numerous colour illustrations. The themes of the texts are as follows.

1. *Differential equations.* Book 1 contains an introductory unit summarising the assumed background knowledge. This is followed by two units on differential equations. Many physical laws are described by differential equations, which makes them perhaps the most important tool in applying mathematics.

2. *Linear algebra.* Scientists and engineers often want to understand complicated systems, with a large number of variables. (For example, you might want to calculate the electrical current flowing through every part of a complicated circuit.) There is a special class of equations, called linear equations, where these calculations can be done. There are three units in Book 2, describing solutions of systems of linear equations, and the important concepts of eigenvalue and eigenvector.

3. *Scalar and vector fields.* The calculus that was described in earlier modules was restricted to functions of just one variable. However, scientists need to understand phenomena in two- or three-dimensional spaces, where quantities may have direction as well as magnitude: describing how wind speed varies with position on the surface of the Earth is a typical example. Four units are devoted to explaining how ideas about differentiation and integration extend to vector fields, and how the ideas of calculus are extended into three-dimensional space.

4. *Advanced topics.* The most sophisticated physical theories that are treated in this module involve differential equations in three-dimensional space. These are called partial differential equations, and a technique called Fourier analysis is required to obtain solutions. The final book contains units on Fourier series and partial differential equations. It

concludes with a brief introduction to dynamical systems, which are discussed in terms of models for populations of animals.

Handbook

The Handbook is provided to give you a convenient source of notation and definitions, for use throughout the year and during the exam. It is a good idea to start using the Handbook right from the beginning of the module, so that you may familiarise yourself with its contents.

Only the printed copy of the Handbook sent to you in the mailing can be taken into the exam; copies downloaded from the module website will not be allowed. The rule for annotation is described in the Examination arrangements booklet under the heading 'special annotation', which states: Unrestricted annotation is allowed in module materials listed as permitted in the examination (including any end-papers or blank pages sent to you as part of the module materials), but no additional sheets of notes, inserts, 'post-its' or index tabs. Further details can be found on the module website.

Website

You can access the module website from your StudentHome web page. There you will find the Study planner, the tutor-marked assignments (TMAs), the interactive computer-marked assignments (iCMAs), and the specimen exam paper and its solutions, which are available only through the module website. It is important that you check the website frequently, as Errata and News items will be posted there.

The module website will give you access to the forums, which you can use to communicate with other students and with the MST224 team.

You will also find links to 'screencasts', which are online presentations illustrating how to solve some typical problems.

Assessment

The assessment comprises 4 tutor-marked assignments (TMAs), 4 interactive computer-marked assignments (iCMAs) and an examination.

You must achieve 30% on any given TMA or iCMA for it to count as 'satisfactorily submitted'. Though the module team would encourage you to submit all of the assignments, we do not require this. To pass the continuous assessment requirement, you must satisfactorily submit either (a) all 4 TMAs or (b) 3 TMAs and 3 iCMAs. If you meet this continuous assessment requirement, then your result will be determined on the basis of the exam alone.

You will have only one opportunity to submit each iCMA, so we have added several practice quizzes to the module website so that you can get used to answering questions of a similar nature.

Both the iCMAs and the TMAs will focus strongly on learning through practice rather than on assessment. The feedback that you receive on your answers will help you to improve your knowledge and understanding of the study material and to develop important skills associated with the module.

Although your scores in the continuous assessment will not contribute directly to your overall grade, these assignments form an essential part of the learning process.

Please note that the Assessment Calculator is not available on this module.

Exam

There is a three-hour exam at the end of MST224 that is based on the material in Books 1 to 4. You should familiarise yourself with the format of the exam well in advance.

A specimen exam paper will be added to the MST224 website in due course, and you should work through this carefully before the exam. Sample solutions are also provided. You will be allowed to take into the exam the MST224 Handbook, which you may annotate as described above. No other materials will be allowed.

Support for your studies

It is important to try to keep up to schedule. Each assignment cut-off date is usually very soon after the end of the last study week for the relevant book. We recommend that you try to finish the assignment questions relating to each part of a book as soon as you finish that part. Otherwise, you will have a lot of work to do in a few days before the cut-off date.

Your tutor

Your tutor is there to help you to understand the ideas in MST224, and will provide comments and feedback on your written assignments to help you with your studying. You are advised to go through each marked assignment in detail, and to take note of the comments written by your tutor; they will help you to avoid similar errors in later TMAs and in the exam. Try to attend tutorials – either face-to-face or electronic – there you will have the opportunity to talk to your tutor directly and, just as important, to talk to other students.

Your fellow students

One of the best ways of learning is by talking about your work with fellow students. Unfortunately, in level 2 modules you may see them only at the infrequent tutorials during the year. That leaves a lot of weeks when you could be on your own. A convenient way to keep in touch is to use the MST224 forums.

Other support

You are not expected to study alone. Support is available from your tutor, through face-to-face and electronic tutorials, and via the MST224 website. If you experience difficulties that are not directly related to the content of MST224, you are welcome to contact your Learner Support Team (see your StudentHome page for details).